CLAIMS

WE CLAIM:

1. A method for fabricating a MEMS device onto a substrate having a movable MEMS element portion free from the substrate and disposed adjacent a stationary MEMS element that is in mechanical communication with the substrate, the method comprising the steps of:

(a) providing a wafer having opposed first and second surfaces;

(b) forming a recess into the first surface to produce a spacer member disposed at a periphery of the recess;

(c) mechanically connecting the spacer member to the substrate to form a composite structure having a void disposed therein; and

(d) removing a portion of the wafer to expose the void and to release the movable MEMS element from the stationary MEMS element.

2. The method as recited in claim 1, wherein step (a) further comprises depositing a first layer onto the first surface of the wafer, and wherein step (b) further comprises depositing the spacer member onto the first layer.

3 The method as recited in claim 2, wherein step (b) further comprises etching a portion of the spacer member to form the recess.

4. The method as recited in claim 3, wherein step (d) further comprises etching into the second surface of the wafer to 1) produce a gap that is at least partially aligned with the void, and 2) expose a portion of the first layer that is aligned with the gap.

5. The method as recited in claim 4, wherein step (d) further comprises etching the exposed portion of the first layer into the void to release the movable MEMS element.

6. The method as recited in claim 5, wherein the gap further comprises a variable size gap that varies in response to movement by the movable MEMS element.

7. The method as recited in claim 5, wherein the wafer is conductive.

8. The method as recited in claim 7, wherein the wafer comprises silicon.

9. The method as recited in claim 7, wherein the first layer is an insulator.

10. The method as recited in claim 9, wherein the first layer is selected from the group consisting of silicon nitride and silicon dioxide.

11. The method as recited in claim 1, wherein step (b) further comprises attaching a first layer onto the first surface of the wafer proximal the recess.

12. The method as recited in claim 11, wherein step (d) further comprises etching into the second surface of the wafer at a location aligned with the void to expose a portion of the first layer.

13. The method as recited in claim 12, wherein step (d) further comprises etching the exposed portion of the first layer into the void to release the movable MEMS element.

14. The method as recited in claim 13, wherein step (d) further comprises producing a variable size gap disposed between the movable MEMS element and the stationary MEMS element.

15. The method as recited in claim 11, further comprising depositing the first layer is deposited onto the first surface of the wafer.

16. The method as recited in claim 15, wherein the first layer is selected from the group consisting of silicon nitride and silicon dioxide.

17. The method as recited in claim 15, further comprising growing the first layer onto the first surface of the wafer.

18. The method as recited in claim 17, wherein the first layer is an oxide.

19. The method as recited in claim 11, wherein the first layer is an insulator.

20. The method as recited in claim 1, wherein step (a) further comprises depositing the spacer member onto the first surface.

21. The method as recited in claim 20, wherein step (b) further comprises etching into the spacer member to form the recess.

22. The method as recited in claim 21, further comprising, before step (c), depositing a first layer onto the wafer proximal the recess.

23. The method as recited in claim 22, wherein the first layer is selected from the group consisting of silicon nitride and silicon dioxide.

24. The method as recited in claim 22, wherein step (d) further comprises etching into the second surface of the wafer at a location aligned with the void to expose a portion of the first layer.

25. The method as recited in claim 24, wherein step (d) further comprises etching the exposed portion of the first layer into the void to release the movable MEMS element.

26. The method as recited in claim 25, wherein step (d) further comprises producing a variable size gap disposed between the movable MEMS element and the stationary MEMS element.

27. The method as recited in claim 22, wherein the first layer is an insulator.

28. The method as recited in claim 1, further comprising etching into the wafer to produce the stationary MEMS element having first and second conductive elements that are electrically isolated from each other.

29. The method as recited in claim 1, further comprising etching into the wafer to produce the movable MEMS element having at least two conductive elements that are electrically isolated from each other.

30. The method as recited in claim 1, wherein the substrate is conductive.

31. The method as recited in claim 30, wherein the substrate is selected from the group consisting of silicon, silicon carbide, and gallium arsenide.

32. The method as recited in claim 30, wherein the spacer member is an insulator.

33. The method as recited in claim 1, wherein the substrate is nonconductive.

34. The method as recited in claim 33, wherein the substrate is selected from the group consisting of glass, high resistivity silicon, crystalline sapphire, and ceramic.

35. A method for fabricating a MEMS device having a movable MEMS element disposed adjacent a stationary MEMS element that is in mechanical communication with a substrate, the method comprising the steps of:

(a) providing a wafer having first and second opposing surfaces;

(b) depositing a first layer onto the first surface of the wafer;

(c) depositing a spacer member onto the first layer;

(d) removing a middle portion of the spacer member so as to define a recess disposed between remaining spacer material;

(e) attaching the remaining spacer material to a substrate to form a composite structure having a void disposed therein;

(f) removing a portion of the wafer to expose a portion of the first layer that is at least partially aligned with the void; and

(g) removing a portion of the exposed portion of the first layer to expose the void and release the movable MEMS element.

36. The method as recited in claim 35, wherein steps (f) and (g) further comprise etching the wafer and exposed portion of the first layer, respectively.

37. The method as recited in claim 35, further comprising creating a variable size gap between the movable MEMS element and stationary MEMS element.

38. The method as recited in claim 35, wherein the first layer is an insulator.

39. The method as recited in claim 38, wherein the first layer is selected from the group consisting of silicon dioxide and silicon nitride.

40. The method as recited in claim 35, wherein the spacer is an insulator.

41. The method as recited in claim 40, wherein the spacer is selected from the group consisting of silicon nitride and silicon dioxide.

42. The method as recited in claim 35, wherein steps (f) and (g) further comprise creating the movable MEMS element having at least a pair of conductive members that are electrically isolated from each other by the first layer.

43. The method as recited in claim 35, further comprising fabricating the stationary MEMS element having a pair of conductive members that are electrically isolated from each other by at least one of the remaining spacer material and the substrate.

44. The method as recited in claim 35, wherein the wafer is conductive.

45. A method for fabricating a MEMS device onto a substrate having a movable MEMS element portion free from the substrate and disposed adjacent a stationary MEMS element that is in mechanical communication with the substrate, the method comprising the steps of:

(a) providing a wafer having opposed first and second surfaces;

(b) depositing a spacer material onto the first surface of the wafer;

(c) forming a recess within a middle portion of the spacer material.

(d) attaching a first layer to an upper surface of the recess;

(e) attaching the spacer material to the substrate to form a composite structure having a void disposed therein;

(e) removing a portion of the wafer to expose a portion of the first layer that is at least partially aligned with the void; and

(f) removing the exposed portion of the first layer to release the movable MEMS element.

46. The method as recited in claim 45, wherein removing steps (e) and (f) further comprise etching the portion of the wafer and the exposed portion of the first layer, respectively.

47. The method as recited in claim 45, wherein the substrate is conductive.

48. The method as recited in claim 47, wherein the spacer material is an insulator.

49. The method as recited in claim 47, wherein the substrate is selected from the group consisting of silicon, silicon carbide, and gallium arsenide.

50. The method as recited in claim 48, wherein the spacer is selected from the group consisting of silicon nitride and silicon dioxide.

51. The method as recited in claim 45, wherein the wafer is conductive.

52. The method as recited in claim 45, wherein the first layer is an insulator.

53. The method as recited in claim 52, wherein the first layer is selected from the group consisting of silicon dioxide and silicon nitride.

54. The method as recited in claim 45, wherein the movable MEMS element includes a pair of conductive members that are electrically isolated from each other.

55. The method as recited in claim 45, wherein the stationary MEMS element includes a pair of conductive members that are electrically isolated from each other.

56. The method as recited in step 45, further comprising creating a variable size gap between the movable MEMS element and the stationary MEMS element.

57. A method for fabricating a MEMS device onto a substrate having a movable MEMS element portion free from the substrate and disposed adjacent a stationary MEMS element that is in mechanical communication with the substrate, the method comprising the steps of:

(a) providing a wafer having opposed first and second surfaces;

(b) depositing a spacer material onto the first surface of the wafer;

(c) forming a recess within a middle portion of the spacer material.

(d) attaching the spacer material to the substrate to form a composite structure having a void disposed therein; and

(e) removing a portion of the wafer to expose the void and release the movable MEMS element.